

June 1996



Chemistry 30

Grade 12 Diploma Examination

Alberta
EDUCATION

CURRHIST
LB
3054
C2
D422
1996:
June



EX LIBRIS
UNIVERSITATIS
ALBERTÆNSIS

Copyright 1996, the Crown in Right of Alberta, as represented by the Minister of Education, Alberta Education, Student Evaluation Branch, 11160 Jasper Avenue, Edmonton, Alberta T5K 0L2. All rights reserved. Additional copies may be purchased from the Learning Resources Distributing Centre.

Special permission is granted to **Alberta educators only** to reproduce, for educational purposes and on a non-profit basis, parts of this examination that do **not** contain excerpted material **only after the administration of this examination**.

Excerpted material in this examination **shall not** be reproduced without the written permission of the original publisher (see credits page, where applicable).

June 1996

Chemistry 30

Grade 12 Diploma Examination

Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 44 multiple-choice and 12 numerical-response questions, of equal value, worth 70% of the examination
- 2 written-response questions, each worth 15% of the examination

This examination contains sets of related questions

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

When required, a grey bar is used to indicate the end of a set.

A chemistry data booklet is provided for your reference.

The perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Read each question carefully.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

- A.** chemistry
B. biology
C. physics
D. science

Answer Sheet

● (B) (C) (D)

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.

(Record your answer to three digits on the answer sheet.)

Average = $(21.0 + 25.5 + 24.5)/3$
 = 23.666
 = 23.7 (rounded to three digits)

Record 23.7 on the answer sheet —

2	3	.	7
○	●		
○0	○0	○0	○0
○1	○1	○1	○1
●3	○2	○2	○2
○3	●2	○3	○3
○4	○4	○4	○4
○5	○5	○5	○5
○6	○6	○6	○6
○7	○7	○7	●7
○8	○8	○8	○8
○9	○9	○9	○9

Correct-order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____.
(Record all four digits on the answer sheet.)

- 1 physics
- 2 chemistry
- 3 biology
- 4 science

Answer 3214

Record 3214 on the answer sheet →

3	2	1	4
•	•		
0	0	0	0
1	1	●	1
2	●	2	2
●	3	3	3
4	4	4	●
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Written Response

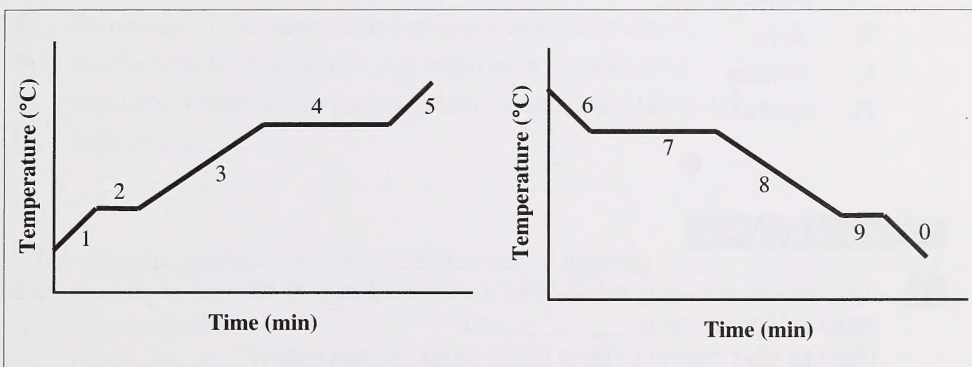
- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and made explicit.
- Description and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.



Digitized by the Internet Archive
in 2016

1. If the only form of energy that increases or decreases during a process is the kinetic energy, then there is a change in the
- A. nuclear binding energy
 - B. nature of the chemical bonds
 - C. temperature of the substance
 - D. phase of the substance

Use the following information to answer the next question.



Numerical Response

1. Select the four appropriate segments from the above graphs that could be used to construct a graph that represents a sample of ice and water at 0°C vaporizing to steam at 150°C . The segments in sequence from left to right are _____.
(Record all four digits on the answer sheet.)

The combustion of fossil fuels such as propane, $\text{C}_3\text{H}_{8(g)} + 5 \text{O}_{2(g)} \rightarrow 3 \text{CO}_{2(g)} + 4 \text{H}_2\text{O}_{(g)}$, plays an important role in our daily lives and affects the economic and environmental climate in Alberta.

2. The original source of the energy stored in fossil fuels such as propane was
- A. protozoa
 - B. plants
 - C. animals
 - D. the Sun

Numerical Response

2. The amount of energy released by the **formation** of 0.100 mol of propane under standard conditions is _____ kJ.

(Record your answer to three digits on the answer sheet.)

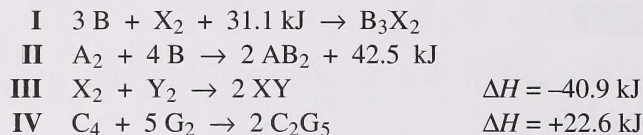
3. When propane is burned in a barbeque, the molar heat of reaction is
- A. -103.8 kJ/mol
 - B. $+103.8 \text{ kJ/mol}$
 - C. $+2043.9 \text{ kJ/mol}$
 - D. -2043.9 kJ/mol

Use the value selected in **Multiple Choice 3** to answer **Numerical Response 3**.

Numerical Response

- 3.** If 449 g of propane are burned in a barbeque, the amount of energy released is _____ MJ.
(Record your answer to three digits on the answer sheet.)
- 4.** When the combustion of fuels, such as propane, is compared to cellular respiration,
- A.** combustion is exothermic and respiration is endothermic
 - B.** combustion is endothermic and respiration is exothermic
 - C.** respiration requires the presence of light and combustion does not
 - D.** both produce $\text{CO}_{2(g)}$
- 5.** When propane undergoes combustion, the type of bonding change primarily involved is
- A.** intramolecular
 - B.** intermolecular
 - C.** intranuclear
 - D.** ionic
-

Use the following information to answer the next question.



6. Which of the above reactions is/are exothermic?

- A. II only
- B. III only
- C. I and IV only
- D. II and III only

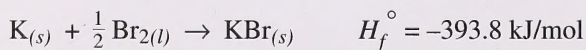
Use the following information to answer the next question.

- | | |
|------------|-------------------------------------|
| I | Solidification of molten aluminum |
| II | Melting of snow |
| III | Appearance of frost on a car window |
| IV | Heating of water |

7. Which of the above changes are exothermic?

- A. I and II
- B. I and III
- C. II and III
- D. II, III, and IV

Use the following information to answer the next question.



8. Using only the information given above, which valid interpretation can be made?

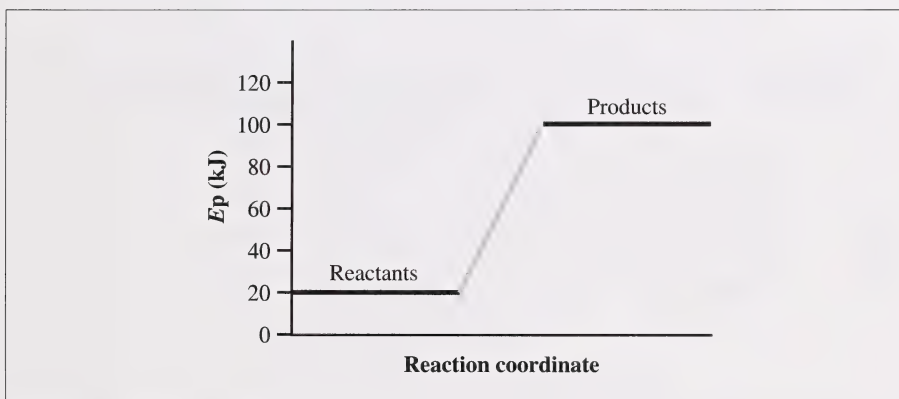
- A. The equation represents a phase change.
- B. The dissolving of $\text{KBr}_{(s)}$ is an exothermic process.
- C. The decomposition of $\text{KBr}_{(s)}$ is an endothermic process.
- D. $\text{KBr}_{(s)}$ is less stable than its constituent elements.

Use the following information to answer the next question.

A student was asked to determine the molar enthalpy of solution of potassium hydroxide. She poured 100 g of water into an insulated cup and recorded the temperature of the water. She then added 2.00 g of $\text{KOH}_{(s)}$ to the water, stirred the solution, and recorded the highest temperature reached. Her analysis of the data resulted in an answer of -46 kJ/mol .

9. If the student had used 4.00 g of $\text{KOH}_{(s)}$, the
- A. temperature change would double and the molar heat of reaction would double
 - B. heat released would be the same but the moles of KOH would double
 - C. heat released would double but the molar heat of reaction would remain the same
 - D. temperature would double and, because the mass of KOH had doubled, the molar heat of reaction would be four times as great

Use the following potential-energy diagram to answer the next question.



10. The heat of reaction is
- A. -100 kJ
 - B. -80 kJ
 - C. $+80 \text{ kJ}$
 - D. $+100 \text{ kJ}$

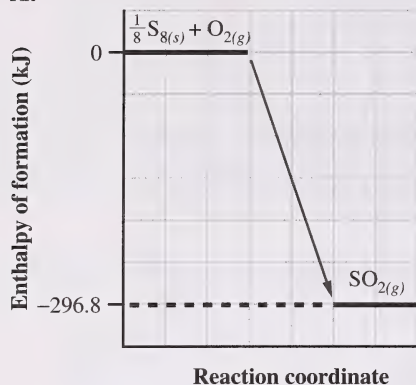
11. Compound X has a molar mass of 75.0 g/mol. The combustion of 300.0 g of compound X causes the temperature of 1000.0 g of water to rise 3.00°C. The molar heat of combustion for compound X is
- A. -3.14 kJ/mol
 - B. -3.77 kJ/mol
 - C. -12.6 kJ/mol
 - D. -50.3 kJ/mol
12. Of the following, the equation representing the **least** change in energy is
- A. $\text{F}_{2(g)} \rightarrow \text{F}_{2(l)}$
 - B. ${}^{19}_9\text{F} + {}^4_2\text{He} \rightarrow {}^1_0\text{n} + {}^{22}_{11}\text{Na}$
 - C. $2\text{F}_{2(g)} + 2\text{H}_2\text{O}_{(l)} \rightarrow \text{O}_{2(g)} + 4\text{HF}_{(aq)}$
 - D. $\text{CH}_{4(g)} + 2\text{Cl}_{2(g)} + 2\text{F}_{2(g)} \rightarrow \text{CCl}_2\text{F}_{2(g)} + 2\text{HCl}_{(g)} + 2\text{HF}_{(g)}$
13. Pure copper can be obtained by roasting copper ore with carbon monoxide. The heat of reaction for $\text{CuO}_{(s)} + \text{CO}_{(g)} \rightarrow \text{Cu}_{(s)} + \text{CO}_{2(g)}$ is
- A. -125.7 kJ
 - B. -236.2 kJ
 - C. -504.0 kJ
 - D. -661.3 kJ
14. Hydrogen peroxide slowly decomposes to water and oxygen. A small amount, 0.010 g, of black $\text{MnO}_{2(s)}$ is added to a test tube containing hydrogen peroxide. As a result, the rate of bubble formation increases, the temperature increases more rapidly, a glowing splint relights above the liquid, and 0.010 g of black residue remains. These results indicate that
- A. $\text{MnO}_{2(s)}$ reacts with peroxide to form $\text{O}_{2(g)}$
 - B. $\text{MnO}_{2(s)}$ decomposes to produce $\text{O}_{2(g)}$
 - C. $\text{MnO}_{2(s)}$ reacts with peroxide to form $\text{H}_{2(g)}$
 - D. $\text{MnO}_{2(s)}$ acts as a catalyst in the reaction

A problem of global concern is acid deposition, more commonly referred to as acid rain. Some acidity in rainwater is normal due to the dissolving of atmospheric carbon dioxide, but the minimum pH value that can be attributed to this is 5.6. Much lower pH values have been measured in rain and snow in many parts of the world. This drop in pH is primarily caused by the burning of fossil fuels, which releases oxides of sulphur and nitrogen into the atmosphere.

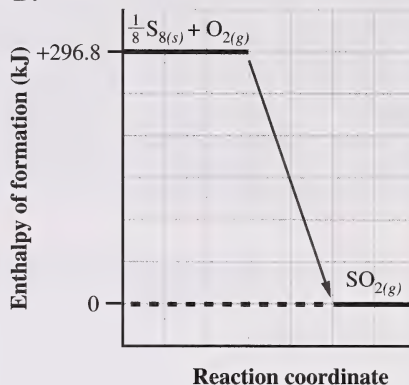
15. Coal is composed mainly of carbon. The thermochemical equation that correctly represents the complete combustion of carbon is
- A. $\text{C}_{(s)} + \text{O}_{2(g)} \rightarrow \text{CO}_{2(g)} \quad \Delta H = +393.5 \text{ kJ}$
- B. $\text{C}_{(s)} + \text{O}_{2(g)} \rightarrow \text{CO}_{2(g)} \quad \Delta H = -393.5 \text{ kJ}$
- C. $2 \text{C}_{(s)} + \text{O}_{2(g)} \rightarrow 2 \text{CO}_{(g)} \quad \Delta H = -221.0 \text{ kJ}$
- D. $2 \text{C}_{(s)} + \text{O}_{2(g)} \rightarrow 2 \text{CO}_{(g)} \quad \Delta H = +221.0 \text{ kJ}$

16. Sulphur, $S_{8(s)}$, is present in coal. When coal is burned, $SO_{2(g)}$ is formed. The potential-energy diagram that **best** represents this reaction is

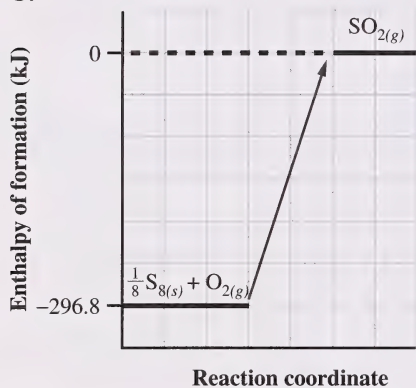
A.



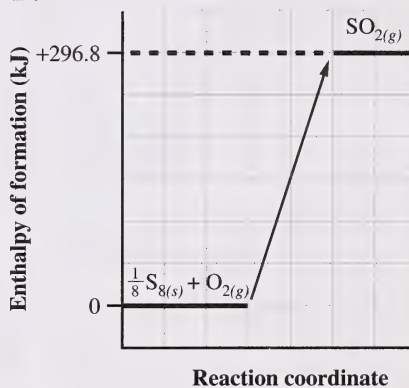
B.



C.



D.

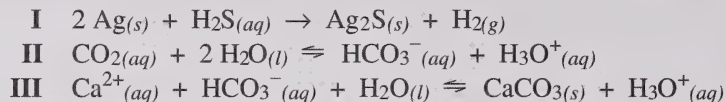


17. The $NO_{2(g)}$ emitted by automobiles can react with rainwater in the atmosphere to form a mixture of $HNO_{2(aq)}$ and $HNO_{3(aq)}$. This mixture can

- A. oxidize silver but not gold
- B. oxidize copper but not silver
- C. reduce iron(III) ions but not zinc ions
- D. reduce silver ions but not iron(III) ions

18. Cars today are smaller, more fuel-efficient, and operate at higher engine temperatures than cars in the past. A disadvantage of this from an **ecological** perspective is that
- A. cars cost more to maintain
 - B. cars release more $\text{CO}_{2(g)}$ into the atmosphere
 - C. at higher engine temperatures more $\text{NO}_{(g)}$ is produced
 - D. less fuel consumption results in layoffs in the energy sector
19. In 1974, a sample of rain in Scotland was analyzed and found to have a pH of 2.20. The pOH and the hydroxide ion concentration in this sample were
- A. 11.80 and $6.3 \times 10^{-3} \text{ mol/L}$
 - B. 11.80 and $1.6 \times 10^{-12} \text{ mol/L}$
 - C. 2.20 and $6.3 \times 10^{-3} \text{ mol/L}$
 - D. 2.20 and $1.6 \times 10^{-12} \text{ mol/L}$

Treasures found in sunken Spanish galleons sometimes contain silver coins in wooden chests. After many years under water, these coins become coated through the following sequence of chemical reactions:



20. In reaction I, the silver

- A. gained electrons and was reduced
- B. gained electrons and was oxidized
- C. lost electrons and was reduced
- D. lost electrons and was oxidized

21. Reaction I resulted in

- A. an increase in the pH as $\text{H}_{2(g)}$ was produced
- B. a decrease in the pH as $\text{H}_{2(g)}$ was produced
- C. an increase in the pH as $\text{H}_2\text{S}_{(aq)}$ was consumed
- D. a decrease in the pH as $\text{H}_2\text{S}_{(aq)}$ was consumed

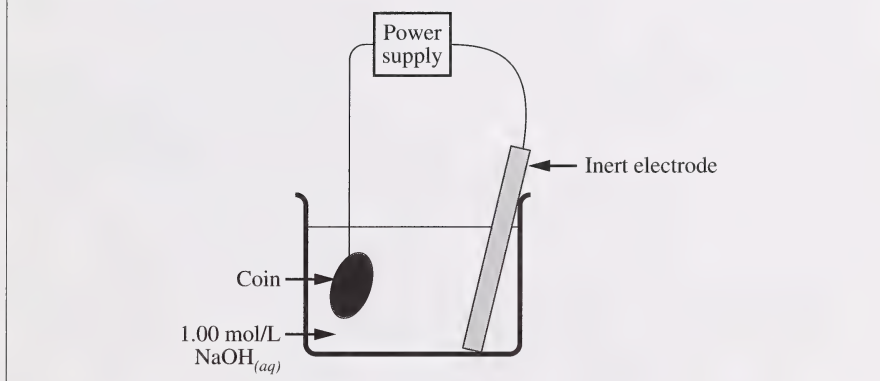
22. The K_a expression for reaction II is

- A. $K_a = \frac{[\text{HCO}_3^{-}(aq)][\text{H}_3\text{O}^{+}(aq)]}{[\text{CO}_{2(aq)}][\text{H}_2\text{O}_{(l)}]}$
- B. $K_a = \frac{[\text{HCO}_3^{-}(aq)][\text{H}_3\text{O}^{+}(aq)]}{[\text{CO}_{2(aq)}]}$
- C. $K_a = \frac{[\text{CO}_{2(aq)}][\text{H}_2\text{O}_{(l)}]}{[\text{HCO}_3^{-}(aq)][\text{H}_3\text{O}^{+}(aq)]}$
- D. $K_a = [\text{HCO}_3^{-}(aq)][\text{H}_3\text{O}^{+}(aq)]$

23. The limestone, $\text{CaCO}_{3(s)}$, that would eventually cover the silver coins could be removed by
- A. adding a basic solution
 - B. decreasing the pH of the system
 - C. adding sodium hydrogen carbonate solution
 - D. increasing the pressure on the system

Use the following information to answer the next two questions.

In order to remove the $\text{Ag}_2\text{S}_{(s)}$, the coins could be attached to the cathode of an electrolytic cell containing 1.00 mol/L sodium hydroxide solution.



24. The **most** likely cathode reaction would be
- A. $\text{Ag}_2\text{S}_{(s)} + 2\text{e}^- \rightarrow 2\text{Ag}_{(s)} + \text{S}^{2-}_{(aq)}$
 - B. $\text{Ag}^+_{(aq)} + \text{e}^- \rightarrow \text{Ag}_{(s)}$
 - C. $2\text{Ag}_{(s)} + \text{S}^{2-}_{(aq)} \rightarrow \text{Ag}_2\text{S}_{(s)} + 2\text{e}^-$
 - D. $\text{Ag}_{(s)} \rightarrow \text{Ag}^+_{(aq)} + \text{e}^-$

Numerical Response

4. Assuming standard conditions, the theoretical minimum voltage that would have to be exceeded to operate the electrolytic cell is _____ V.
(Record your answer to three digits on the answer sheet.)

Titration is an important procedure in the analysis of water samples. One common test is a water hardness test, which determines the concentration of dissolved metals such as calcium. A sample of water is titrated using tetrasodium EDTA, $\text{Na}_4\text{C}_{10}\text{H}_{12}\text{O}_8\text{N}_2(\text{aq})$. The tetrasodium EDTA reacts with the $\text{Ca}^{2+}(\text{aq})$ to form a soluble complex. This change can be detected by using the indicator murexide, $\text{C}_8\text{H}_8\text{N}_6\text{O}_6(\text{aq})$, which changes from an **initial** red colour to a **final** purple colour.

25. The equation for this reaction is

- A. $\text{Na}_4\text{C}_{10}\text{H}_{12}\text{O}_8\text{N}_2(\text{aq}) + \text{Ca}^{2+}(\text{aq}) \rightarrow \text{CaNa}_2\text{C}_{10}\text{H}_{12}\text{O}_8\text{N}_2(\text{aq}) + 2\text{Na}^+(\text{aq})$
 B. $\text{Na}_4\text{C}_{10}\text{H}_{12}\text{O}_8\text{N}_2(\text{aq}) + \text{Ca}(\text{s}) \rightarrow \text{CaNa}_2\text{C}_{10}\text{H}_{12}\text{O}_8\text{N}_2^{2-}(\text{aq}) + 2\text{Na}^+(\text{aq})$
 C. $\text{Na}_4\text{C}_{10}\text{H}_{12}\text{O}_8\text{N}_2(\text{aq}) + \text{Ca}^{2+}(\text{aq}) \rightarrow \text{C}_{10}\text{H}_{12}\text{O}_8\text{N}_2(\text{aq})$
 D. $\text{Na}_4\text{C}_{10}\text{H}_{12}\text{O}_8\text{N}_2(\text{aq}) + \text{Ca}(\text{aq}) \rightarrow \text{C}_{10}\text{H}_{12}\text{O}_8\text{N}_2^{2-}(\text{aq})$

Use this titration data to answer the next two questions.

Trial	I	II	III	IV	V
Volume of water sample (mL)	100.0	100.0	100.0	100.0	100.0
Concentration of tetrasodium EDTA (mol/L)	0.125	0.125	0.125	0.125	0.125
Initial volume of tetrasodium EDTA (mL)	50.00	50.00	50.00	50.00	50.00
Final volume of tetrasodium EDTA (mL)	47.18	41.50	46.97	47.12	47.01
Final colour of solution	purple	red	purple	purple	purple

Numerical Response

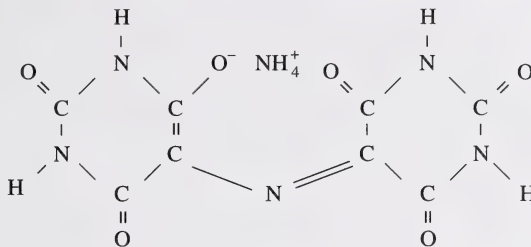
5. The volume of tetrasodium EDTA that should be used in calculating the “hard water” concentration is _____ mL.
 (Record your answer to three digits on the answer sheet.)

Use your recorded value from Numerical Response 5 to answer Numerical Response 6.

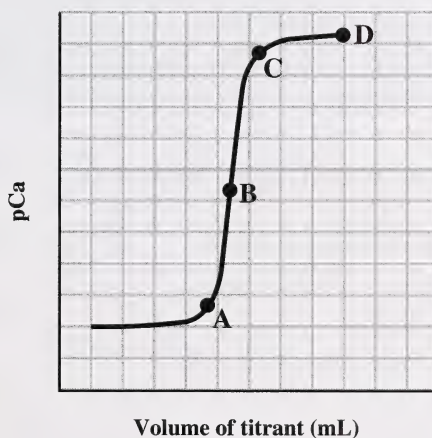
Numerical Response

6. Assuming that the “the hardness of water” is due solely to dissolved calcium, the concentration of $\text{Ca}^{2+}(\text{aq})$ is _____ mmol/L.
 (Record your answer to three digits on the answer sheet.)

26. The oxidation state of hydrogen in murexide, $\text{C}_8\text{H}_8\text{N}_6\text{O}_6(\text{aq})$,

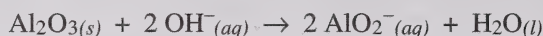


- A. is +1
 B. is 0
 C. is -1
 D. varies
27. Titration curves are drawn for reactions involving metallic ions by plotting the negative log of the metallic ion concentration, such as pCa , against the volume of titrant. The equivalence point of the reaction in the water hardness analysis is at point

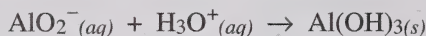


Aluminum is produced commercially by the Hall–Heroult process, which involves the electrolysis of $\text{Al}_2\text{O}_3(l)$. The aluminum is obtained from the bauxite, which contains $\text{Al}_2\text{O}_3(s)$ and impurities that must be removed before electrolysis. The purification process involves three stages:

- I** The crushed ore is treated with concentrated $\text{NaOH}_{(aq)}$, which dissolves the $\text{Al}_2\text{O}_3(s)$ but not the impurities. The impurities are removed by filtration.



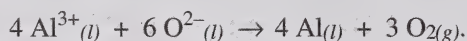
- II** The solution is acidified to precipitate $\text{Al}(\text{OH})_3(s)$.



- III** The precipitate is heated to yield pure $\text{Al}_2\text{O}_3(s)$.



The purified $\text{Al}_2\text{O}_3(s)$ is then added to a molten electrolyte in which it ionizes. Electrolysis of this mixture produces aluminum metal. The net ionic equation for the electrolysis reaction is



28. In the electrolytic cell, $\text{Al}_{(l)}$ is produced at the

- A. anode where oxidation occurs
- B. anode where reduction occurs
- C. cathode where oxidation occurs
- D. cathode where reduction occurs

29. The bauxite must be purified since it may contain

- A. cations that are stronger reducing agents than $\text{Al}^{3+}_{(l)}$
- B. cations that are stronger oxidizing agents than $\text{Al}^{3+}_{(l)}$
- C. anions that are stronger oxidizing agents than $\text{O}^{2-}_{(l)}$
- D. anions that are stronger reducing agents than $\text{O}^{2-}_{(l)}$

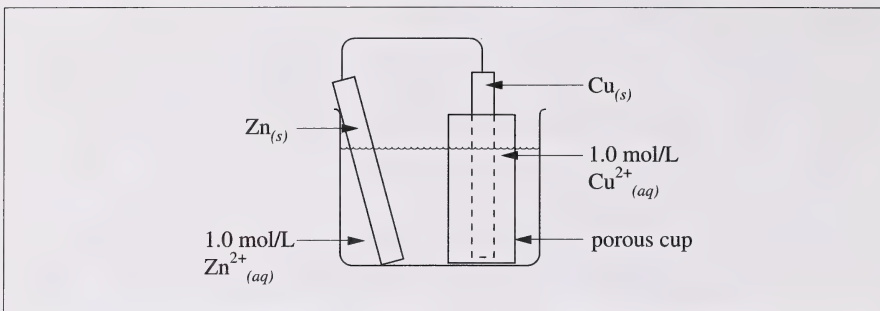
Numerical Response

7. If the standard molar heat of formation for $\text{Al}(\text{OH})_{3(s)}$ is -1284.8 kJ/mol , then the energy required to produce 22.1 g of $\text{Al}_2\text{O}_{3(s)}$ in equation III is _____ kJ.

(Record your answer to three digits on the answer sheet.)

30. Which generalization about the Standard Electrode Potential Table is valid?
- A. Metallic ions and non-metallic elements are generally oxidizing agents.
 - B. Metallic ions and non-metallic ions are generally reducing agents.
 - C. Metallic elements and non-metallic elements are generally reducing agents.
 - D. Metallic elements and non-metallic ions are generally oxidizing agents.
31. In the equation $\text{Au}^{3+}_{(aq)} + 3 \text{NO}_{2(g)} + 3 \text{H}_2\text{O}_{(l)} \rightarrow \text{Au}_{(s)} + 3 \text{NO}_3^{-}_{(aq)} + 6 \text{H}^{+}_{(aq)}$, the oxidizing agent is
- A. $\text{NO}_{2(g)}$
 - B. $\text{H}^{+}_{(aq)}$
 - C. $\text{NO}_3^{-}_{(aq)}$
 - D. $\text{Au}^{3+}_{(aq)}$

Use the following diagram to answer the next question.



32. As the reaction in the cell progresses, the mass of
- both electrodes increases
 - both electrodes decreases
 - the $\text{Zn}_{(s)}$ electrode decreases and the mass of $\text{Cu}_{(s)}$ electrode increases
 - the $\text{Zn}_{(s)}$ electrode increases and the mass of $\text{Cu}_{(s)}$ electrode decreases

Use the following information to answer the next question.

Students are given four solutions.

Solution	Species
1	$\text{A}^+_{(aq)}$
2	$\text{B}^{2+}_{(aq)}$
3	$\text{C}^{2+}_{(aq)}$
4	$\text{D}^{3+}_{(aq)}$

They determine the E° values.

$\text{A}^+_{(aq)} + \text{e}^- \rightarrow \text{A}_{(s)}$	$E^\circ = +0.54 \text{ V}$
$\text{B}^{2+}_{(aq)} + 2 \text{e}^- \rightarrow \text{B}_{(s)}$	$E^\circ = -0.84 \text{ V}$
$\text{C}^{2+}_{(aq)} + 2 \text{e}^- \rightarrow \text{C}_{(s)}$	$E^\circ = -0.35 \text{ V}$
$\text{D}^{3+}_{(aq)} + 3 \text{e}^- \rightarrow \text{D}_{(s)}$	$E^\circ = +0.38 \text{ V}$

Numerical Response

8. When the oxidizing agents are arranged in increasing order of strength, the order of the solutions is _____.
(Record all four digits on the answer sheet.)

The Dow Chemical site at Fort Saskatchewan produces large quantities of chemicals for use in industry. On this site there are two chlor-alkali plants that produce chlorine and other byproducts. The chlor-alkali process involves the electrolysis of $\text{NaCl}_{(aq)}$.

33. The reaction that occurs at the cathode is

- A. $2 \text{H}^+_{(aq)} + 2 \text{e}^- \rightarrow \text{H}_{2(g)}$
- B. $\text{Na}^+_{(aq)} + \text{e}^- \rightarrow \text{Na}_{(s)}$
- C. $2 \text{H}_2\text{O}_{(l)} \rightarrow \text{O}_{2(g)} + 4 \text{H}^+_{(aq)} + 4 \text{e}^-$
- D. $2 \text{H}_2\text{O}_{(l)} + 2 \text{e}^- \rightarrow \text{H}_{2(g)} + 2 \text{OH}^-_{(aq)}$

Use the following information to answer the next question.

Technicians periodically check the concentration of $\text{NaOH}_{(aq)}$ in the chlor-alkali cells. In one test, a 10.0 mL sample of the solution required 44.9 mL of 0.850 mol/L $\text{HCl}_{(aq)}$ to reach the end-point.

34. The concentration of $\text{NaOH}_{(aq)}$ in the sample was

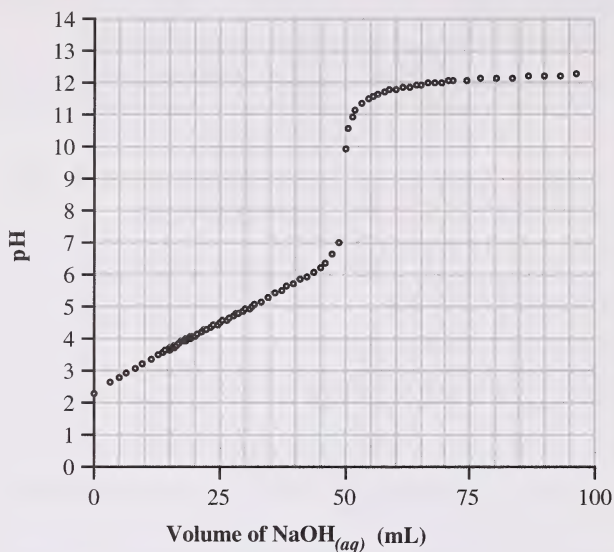
- A. 0.189 mol/L
 - B. 0.695 mol/L
 - C. 3.82 mol/L
 - D. 5.28 mol/L
-

Numerical Response

9. In the chlor-alkali process, the mass of $\text{NaCl}_{(s)}$ required to produce 0.793 kg of chlorine gas is _____ kg.
(Record your answer to three digits on the answer sheet.)

Use the following information to answer the next question.

An acidic solution was titrated with $\text{NaOH}_{(aq)}$ and the points were plotted below.



35. The **best** choice of indicator for this titration is
- orange IV
 - indigo carmine
 - phenolphthalein
 - chlorophenol red
-
36. If some $\text{NaOH}_{(aq)}$ was spilled, the spill could be neutralized by the addition of $\text{NaHSO}_{4(aq)}$. The net ionic equation for this reaction is
- $\text{OH}^{-}_{(aq)} + \text{H}_3\text{O}^{+}_{(aq)} \rightleftharpoons 2 \text{H}_2\text{O}_{(l)}$
 - $\text{OH}^{-}_{(aq)} + \text{HSO}_4^{-}_{(aq)} \rightleftharpoons \text{H}_2\text{O}_{(l)} + \text{SO}_4^{2-}_{(aq)}$
 - $\text{NaOH}_{(aq)} + \text{NaHSO}_{4(aq)} \rightleftharpoons \text{H}_2\text{O}_{(l)} + \text{Na}_2\text{SO}_{4(aq)}$
 - $2 \text{Na}^{+}_{(aq)} + \text{OH}^{-}_{(aq)} + \text{HCO}_3^{-}_{(aq)} \rightleftharpoons \text{H}_2\text{O}_{(l)} + 2 \text{Na}^{+}_{(aq)} + \text{CO}_3^{2-}_{(aq)}$

37. One condition of a system at equilibrium is that the
- A. reaction proceeds to completion
 - B. concentration of products and reactants are equal
 - C. rate of the forward reaction does not equal the rate of the reverse reaction
 - D. concentration of reactants and products undergoes no change
38. The equation that **best** represents the system of solid ammonium chloride in equilibrium with ammonia gas and hydrogen chloride gas is
- A. $\text{NH}_4\text{Cl}_{(s)} + \text{NH}_{3(g)} \rightleftharpoons \text{HCl}_{(g)} + \text{N}_{2(g)} + 3 \text{H}_{2(g)}$
 - B. $\text{NH}_{3(g)} + \text{HCl}_{(g)} \rightleftharpoons \text{NH}_4\text{Cl}_{(g)}$
 - C. $\text{NH}_4\text{Cl}_{(s)} + \text{HCl}_{(g)} \rightleftharpoons \text{NH}_{3(g)} + \text{H}_{2(g)} + \text{Cl}_{2(g)}$
 - D. $\text{NH}_4\text{Cl}_{(s)} \rightleftharpoons \text{NH}_{3(g)} + \text{HCl}_{(g)}$
39. Sulphuric acid is a
- A. diprotic weak acid
 - B. diprotic strong acid
 - C. monoprotic weak acid
 - D. monoprotic strong acid

Use the following information to answer the next question.

Students subjected six solutions to conductivity and litmus paper tests and obtained these results.

Solution	Conductivity	Litmus Paper Test	
		Red	Blue
1	good	red	blue
2	poor	blue	blue
3	good	red	red
4	none	red	blue
5	good	blue	blue
6	poor	red	red

Numerical Response

10. The solutions that are **not** acids, in ascending numerical order, are _____.
(Record your answer on the answer sheet.)

40. In the acid-base reaction $\text{CH}_3\text{COO}^-_{(aq)} + \text{HSO}_4^-_{(aq)} \rightleftharpoons \text{CH}_3\text{COOH}_{(aq)} + \text{SO}_4^{2-}_{(aq)}$,
- A. products are favoured
 - B. $\text{CH}_3\text{COO}^-_{(aq)}$ is an acid
 - C. $\text{SO}_4^{2-}_{(aq)}$ is a proton donor
 - D. $\text{HSO}_4^-_{(aq)}$ and $\text{CH}_3\text{COOH}_{(aq)}$ are a conjugate acid-base pair
41. Brønsted-Lowry theory defines acids as substances that
- A. accept protons
 - B. increase the $[\text{H}_3\text{O}^+_{(aq)}]$
 - C. turn blue litmus red
 - D. donate protons

Use the following information to answer the next question.

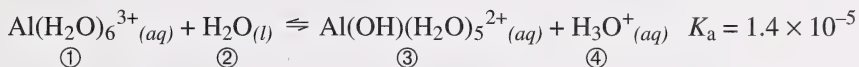
Indicator	Colour
orange IV	yellow
thymol blue	yellow
methyl orange	red
phenolphthalein	pink

42. For which indicator is the colour correct in 0.10 mol/L $\text{HCl}_{(aq)}$ solution?

- A. Orange IV
 - B. Thymol blue
 - C. Methyl orange
 - D. Phenolphthalein
- _____

Use the following information to answer the next question.

Manufacturers used to add alum, $\text{Al}_2(\text{SO}_4)_3(s)$, during the production of paper. The aluminum ion was hydrated and the following equilibrium was established:



Numerical Response

11. In the forward reaction, the Brønsted-Lowry acid is _____.
(Record your answer in the first column on the answer sheet.)

In the forward reaction, the Brønsted-Lowry base is _____.
(Record your answer in the second column on the answer sheet.)

In the reverse reaction, the Brønsted-Lowry acid is _____.
(Record your answer in the third column on the answer sheet.)

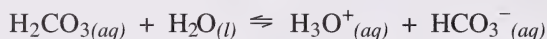
In the reverse reaction, the Brønsted-Lowry base is _____.
(Record your answer in the fourth column on the answer sheet.)

43. $\text{HCl}_{(aq)}$ is added to a neutral solution containing bromothymol blue indicator. Which changes to the solution would you expect?

- A. $[\text{H}_3\text{O}^+_{(aq)}]$ increases, pH decreases, colour becomes more yellow
- B. $[\text{H}_3\text{O}^+_{(aq)}]$ increases, pH increases, colour becomes more yellow
- C. $[\text{OH}^-_{(aq)}]$ increases, pH decreases, colour becomes more blue
- D. $[\text{OH}^-_{(aq)}]$ decreases, pH increases, colour becomes more blue

Use the following information to answer the next question.

An important buffer in blood is the $\text{H}_2\text{CO}_{3(aq)} / \text{HCO}_3^-_{(aq)}$ system. The equilibrium for this buffer is



Numerical Response

12. A sample of this buffer at equilibrium contains $1.1 \times 10^{-4} \text{ mol/L } \text{HCO}_3^-_{(aq)}$ and $1.2 \times 10^{-5} \text{ mol/L } \text{H}_2\text{CO}_{3(aq)}$. The pH of the sample is _____.
(Record your answer to three digits on the answer sheet.)

Use the following information to answer the next question.

Champagne is mixed with orange juice and served at “Champagne Breakfasts.” Orange juice contains sufficient hydronium ions to kill a human if blood were not buffered. One of the buffers in blood is the $\text{H}_2\text{PO}_4^-_{(aq)} / \text{HPO}_4^{2-}_{(aq)}$ system.

44. When a small amount of acid from the beverage enters the bloodstream, the pH is maintained by this buffer because the $\text{H}_3\text{O}^+_{(aq)}$ reacts with
- A. $\text{H}_2\text{PO}_4^-_{(aq)}$ to produce $\text{HPO}_4^{2-}_{(aq)}$
 - B. $\text{H}_2\text{PO}_4^-_{(aq)}$ to produce $\text{H}_3\text{PO}_{4(aq)}$
 - C. $\text{HPO}_4^{2-}_{(aq)}$ to produce $\text{H}_2\text{PO}_4^-_{(aq)}$
 - D. $\text{HPO}_4^{2-}_{(aq)}$ to produce $\text{PO}_4^{3-}_{(aq)}$

Written Response — 12 marks

1. When corrosive materials such as concentrated hydrochloric acid are shipped in tanker trucks, there is always the potential for accidental leakage. What steps should be taken to neutralize an accidental spill of hydrochloric acid in a roadside ditch?

Explain the rationale behind your strategy. Your response should include appropriate chemical equations.

Written Response — 12 marks

2. Household bleach (sodium hypochlorite solution) will remove iodine stains from clothing. The reaction occurs in a basic medium that prevents the formation of hypochlorous acid. The unbalanced redox reaction is



- a. Using oxidation numbers and/or half-reactions, balance the reaction. Calculate the volume of 0.550 mol/L $\text{NaClO}_{(aq)}$ solution required to completely react 1.15 g of $\text{I}_{2(s)}$.

- b. Describe the safety procedures that should be followed in the storage and use of bleach. Explain why these safety procedures should be followed. Your response must include appropriate half-reactions and/or chemical equations.

*You have now completed the examination.
If you have time, you may wish to check your answers.*

No marks will be given for work done on this page.

Fold and tear along perforation.

No marks will be given for work done on this page.

Fold and tear along perforation.

*Tear
Po*

No marks will be given for work done on this page.

Fold and tear along perforation.

CONTENTS:

1 sheet (ans. key) in pocket

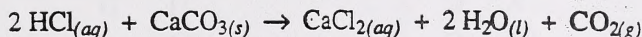
DATE DUE SLIP[®][illegible]

SAMPLE ANSWER KEY FOR WRITTEN-RESPONSE QUESTIONS

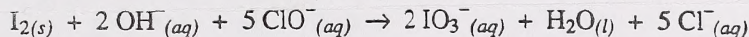
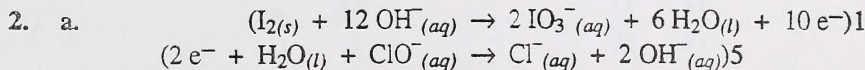
1. Note: Acceptable responses will vary greatly.

The hydrochloric acid could be neutralized on site by the addition of a base such as calcium carbonate (limestone).

The addition of limestone is a good choice because excess limestone would not affect the environment thus an excess can be added and you need not worry about the exact amount required.



The on-site neutralization reduces the shipping and clean up problems since the hydrochloric acid does not need to be gathered up, picked up, and transported away.

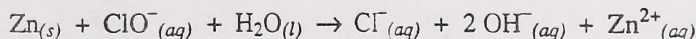


$$\begin{aligned} n_{\text{I}_2} &= 1.15 \text{ g} / 253.8 \text{ g/mol} \\ &= 4.53 \times 10^{-3} \text{ mol} \end{aligned}$$

$$\begin{aligned} \therefore n_{\text{NaClO}} = n_{\text{ClO}^{-}} &= 5/1 n_{\text{I}_2} \\ &= 5/1 (4.53 \times 10^{-3} \text{ mol}) \\ &= 2.27 \times 10^{-2} \text{ mol} \end{aligned}$$

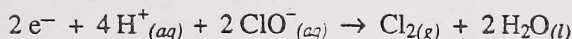
$$\begin{aligned} \therefore V_{\text{NaClO}} &= n/C \\ &= 2.27 \times 10^{-2} \text{ mol} / 0.550 \text{ mol} \\ &= 4.12 \times 10^{-2} \text{ L} \\ &= 41.2 \text{ mL} \end{aligned}$$

- b. Answers will vary greatly. Bleach should not be stored with reducing agents also, because bleach contains a strong oxidizing agent.



or

The bleach should be stored away from acids since acids will react with the bleach to form poisonous chlorine gas.



CHEMISTRY 30 MULTIPLE-CHOICE KEY

1. C	23. B
2. D	24. A
3. D	25. A
4. D	26. A
5. A	27. B
6. D	28. D
7. B	29. B
8. C	30. A
9. C	31. D
10. C	32. C
11. A	33. D
12. A	34. C
13. A	35. C
14. D	36. B
15. B	37. D
16. A	38. D
17. A	39. B
18. C	40. A
19. B	41. D
20. D	42. C
21. C	43. A
22. B	44. C

NUMERICAL RESPONSE KEY

1. 2345	7. 36.5
2. 10.4	8. 2341
3. *	9. 1.31
4. **	10. 1245****
5. 2.93	11. 1243
6. ***	12. 7.32

*If MC3 was A or B - 1.06
C or D - 20.8

**If MC24 was A or C - 1.09
B or D - 0.40

***NR6 = NR5 \times 1.25

****any order



Name

Apply Label With Student's Name

Chemistry 30

(Last Name)

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

(Legal First Name)

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Y

--	--

M

--	--

D

--	--

Name:

Date of Birth:

Sex:

Permanent Mailing Address:

(Apt./Street/Ave./P.O. Box)

(Village/Town/City)

(Posta

--	--	--

School Code:

School:

Signature:

University of Alberta Library



0 1620 0571 3761

For Department Use Only

Holistic 1

--

C1

--

Analytic

--

C2

--

Holistic 2

--

C3

--

Arbitrator

--

C4

--

No Name

Apply Label Without Student's Name

Chemistry 30

